NREL FACTS

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NREL Research

Concentrating Solar Power Research

Using the sun's heat to generate electricity

Commercial prospects for concentrating solar power technologies got brighter when the nation's two leading resources for concentrating solar power research—the National Renewable Energy Laboratory (Golden, Colorado) and Sandia National Laboratories (Albuquerque, New Mexico)—joined together to form a single, unified research laboratory called SunLab.

SunLab, which combines the expertise and experience of the two laboratories, works with concentrating solar power manufacturers and users to develop reliable and efficient systems, increase acceptance of the systems and help the systems penetrate growing domestic and international energy markets.

Concentrating Solar Power

Concentrating solar power technologies convert solar energy into electricity by using reflectors (or concentrators) such as mirrors to focus concentrated sunlight onto a receiver. The receiver transfers the heat to a conventional engine-generator—such as a steam turbine—that generates electricity. There are three types of concentrating solar power systems: power towers (central receivers), dish/engine systems and parabolic troughs. These technologies can be used to generate electricity for a variety of applications, ranging from remote power systems as small as a few kilowatts up to grid-connected applications of 200 megawatts or more.

More than 350 megawatts of concentrating solar power systems have been installed in the U.S. to date. This power meets the needs of over 350,000 people and annually displaces the energy equivalent of 2.3 million barrels of oil.

Technology Development

To reduce costs and improve performance and reliability of concentrating solar power systems, SunLab researchers are developing lower cost solar concentrators, high-efficiency engine/generators and high-performance receivers.

Advanced concentrator technology—Research efforts focus on developing new, innovative designs for solar concentrators that will lead to less expensive, higher-performance heliostats (reflectors) and dishes.

Optical materials—SunLab researchers are developing new reflective materials, such as advanced polymer films that can be produced at a fraction of the cost of glass mirrors and have excellent optical and wear-resistant properties. Researchers test these materials using sophisticated machinery that simulates extended exposure to outdoor conditions. This ultra-accelerated testing facilitates the rapid development and deployment of new optical materials.

Power tower technology—To improve power tower (central receiver) technologies, SunLab and Boeing North American are developing an advanced receiver that is smaller and more efficient than current designs. Researchers also are working with several utilities to examine the feasibility of building hybrid

power towers that run on both solar energy and natural gas. Hybrid power towers could run continuously throughout the day and night.

Dish receiver technology—Researchers are developing an advanced heat pipe receiver for hybrid operation of dish/engine systems. The solar/fossil hybrid design will operate regardless of time of day or weather conditions.

Systems Development

SunLab works in partnership with industry on cost-shared projects aimed at developing and demonstrating concentrating solar power technologies. Major projects include:

Solar Two—A consortium of utility and industry partners, DOE and SunLab converted the existing 10-megawatt Solar One Pilot Plant near Barstow, California, into an advanced molten-salt receiver and thermal storage system. The new storage system enables the power plant to operate three hours after sunset. The added operating time generates electricity during peak demand periods, greatly enhancing the technology's cost effectiveness. The project was cost-shared between DOE and its industry partners.

Dish/engine joint venture programs—Through cost-shared subcontracts, Cummins Power Generation, Inc. is developing a commercial 7.5-kilowatt dish/engine system for remote applications. Cummins and Science Applications International Corporation are each developing commercial dish/engine systems for utilities that generate 25 kilowatts of electricity. The projects are cost-shared between DOE and its industry partners.

Operation and maintenance cost reduction—SunLab researchers are helping plant owners reduce operation and maintenance costs at the Solar Electric Generating System (SEGS) III-VII power plants in Southern California. The power plants have an existing capacity of 150 megawatts of electricity, and are the only utility-scale concentrating solar power plants currently operating in the world. Plant operators expect to reduce costs by 30 percent.

SolMaT—The Solar Thermal Manufacturing Technology (SolMaT) initiative was established to reduce the cost of concentrating solar power technologies. SolMaT efforts include identifying common manufacturing barriers, evaluating processes for manufacturing solar components and testing components to ensure they meet performance and durability goals.

Researchers at NREL are testing a prototype heliostat developed by Science Applications International Corporation under the SolMaT initiative. This prototype heliostat could lead to significant advancements in making power tower systems cost competitive with conventional power sources.

Benefits

Concentrating solar power systems provide an environmentally benign source of energy, produce virtually no emissions and consume no fuel other than sunlight. The systems also have low operating costs, produce power during peak demand periods and provide a secure source of energy. Energy storage allows the plants to operate in cloudy weather and after sunset, and solar/fossil hybrid systems operate around the clock regardless of weather. Concentrating solar power plants also create two and a half times as many skilled jobs than do fossil fuel plants.

Challenges

Concentrating solar power plants are still in the early stages of commercial development and are currently more expensive than fossil fuel plants. Costs can be reduced through economies of scale, as well as through improved component design and advanced systems. Concentrating solar power is appropriate only in regions that receive abundant sunlight.

Potential

During the next decade, worldwide demand for electricity is expected to create markets for new concentrating solar power systems. U.S. government experts speculate that by the year 2020, more than 20 gigawatts of concentrating solar power systems could be installed throughout the world.